

Nuclear Science Division Newsletter

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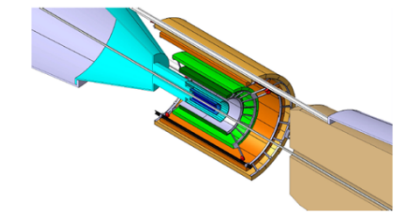
April 2012

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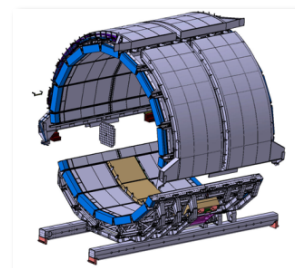
Relativistic Collisions looks forward

The NSDs Relativistic Nuclear Collisions (RNC) Program has active, ongoing research programs at both the STAR experiment at RHIC and the ALICE experiment at the LHC. In STAR, the RNC is playing a leading role in the construction of a revolutionary new vertex detector, the Heavy Flavor Tracker (HFT) that will be installed and commissioned over the next two years. LBNL led the construction of the ALICE Electromagnetic Calorimeter (EMCal), one arm of which is already installed and doing physics, with the second scheduled for completion during the 2013 LHC shutdown.

With the impending successful completion of these projects, it is time for the RNC to look ahead and plan its next major initiatives. The RNC held a Retreat at LBNL for that purpose, during March 21-14, 2012. All members of the RNC, ably assisted by their theory colleagues in the NSD, spent four intensive days discussing physics opportunities, detector upgrades, and new projects at a wide variety of facilities, with emphasis on the period 2015-2025.



One focus was on upgrades of the STAR detector beyond the HFT, including new forward instrumentation, refurbishment of the venerable TPC, and instrumentation for the first generation of experiments with electron beams at RHIC. On the ALICE side, discussion centered on new forward instrumentation, as well as completion of the EMCal Barrel and a new vertex detector, all aimed at installation during the 2018 LHC shutdown. In the longer term, physics opportunities at electron-ion colliders in the US and at CERN were considered. A common theme emerged, addressing low x physics at currently operating hadron colliders and at future electron-ion colliders. Additional discussion focused on new opportunities for QCD studies at fixed target and cosmic ray facilities, together with new directions in instrumentation and computing.



The Retreat looked at a broad array of future projects. The intent was not to make a decision about future activities, but rather to give all of the proposed projects ample consideration. Several areas of particular interest to members of the RNC were identified, along with next steps to develop the physics case leading to specific proposals. The Retreat provided an important milestone for RNC planning, though the process is ongoing. The intention is to narrow the list by the end of the summer, to mesh with the funding cycle, collaboration schedules, and the national planning process.

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No vs is big news as IceCube meets in Berkeley

The non-observation of neutrinos from gamma-ray bursts was a major topic of conversation as the IceCube collaboration visited Berkeley for its spring meeting. 80 collaborators from the U.S., Europe, Japan, New Zealand and Barbados came together for a week of discussion on detector operations, R & D for future upgrades, and, of course, analysis. After welcomes from LBNL Associate Laboratory Director (and NSD director) James Symons and UC Berkeley Chancellor Robert Birgenau, talk quickly turned to brass tacks.

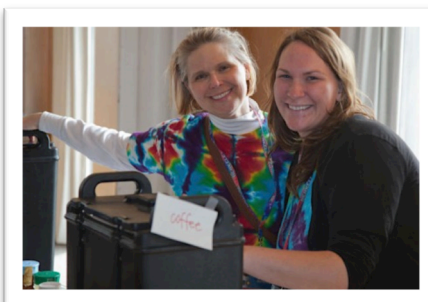


Sessions covered the breadth of IceCube physics, but gamma-ray burst (GRB) phenomenology was a hot topic. The reason for this was the then-impending IceCube paper in *Nature* (*Nature* **484**, 351 (2012), setting limits on neutrinos from GRBs, concluding that either gamma-ray bursts are not the source of the highest energy cosmic rays, or that current theories of GRBs need significant revision. This paper will doubtless spark much theoretical discussion, but for the first time, IceCube has clearly ruled out several 'front-line' theories. A mock "Occupy IceCube" protest led some levity to the scientific sessions.



Other high points included an upcoming paper on the observation of atmospheric electron neutrinos (the first at energies above a few GeV), and a high-statistics study of TeV muons far from the cores of cosmic-ray air showers; these are high transverse momentum ($p_T > \sim 2$ GeV/c) muons produced in the initial cosmic-ray air collisions. Much effort is going toward improving the understanding of detector systematics. One example of progress here is an improved model of light scattering in the ice; this new model significantly reduces the systematic spread in the light emitting diode calibration data. The improved systematics will facilitate precise measurements of atmospheric neutrino oscillations, something that the Collaboration hopes to present for this summer.

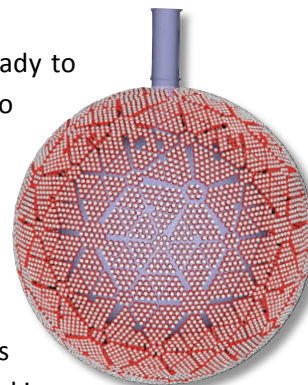
The meeting also included plenty of time for less formal interactions. Highlights of the social program included the collaboration banquet, an IceCube trivia contest ("In what year were the first atmospheric neutrinos detected?", "What is the name of the chapel at McMurdo Station?"), a tour of LBNL's Advanced Light Source, and an evening tour of Alcatraz.



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LBNL digs into SNO+

SNO+, a successor to the venerable Sudbury Neutrino Observatory, is getting ready to take data, with LBNL playing a key role. SNO+ is a multi-purpose neutrino experiment, which will study neutrinoless double beta decay ($0\nu\beta\beta$) and study solar neutrinos at energies below the reach of SNO. SNO+ will preserve the SNO acrylic vessel and photomultiplier tubes (PMTs), along with the original LBNL-designed support structure, but replace the heavy water with ^{150}Nd loaded scintillator. LBNL plays a leading role in the analysis efforts. NSDs Gabriel Orebi Gann is the Deputy Physics Analysis Coordinator (and acting Analysis Coordinator) as well as leading the Solar Neutrino and PMT Calibration working groups. Tony LaTorre is the co-author of a high performance GPU-accelerated optical photon simulation called Chroma, which can propagate photons 200 times faster than GEANT4. The image above shows the SNO+ detector simulated in Chroma.



SNO+ will use ^{150}Nd because it has the highest Q-value of $0\nu\beta\beta$ candidates - critical because the $0\nu\beta\beta$ decay rate is proportional to Q^5 and because most radioactive backgrounds are at lower energies. At 0.3% Nd loading the projected sensitivity to the effective neutrino mass $m_{\beta\beta}$ is 100meV at 90% C.L. in a 3 year run.

The high intrinsic light yield of liquid scintillator allows an extensive solar neutrino program. SNO+ can make a 10% measurement of pep solar neutrinos with a year's worth of data - the first high-precision data point in the transition region of the solar neutrino survival probability, and a sensitive search for potential new physics. A 15% measurement of CNO solar neutrinos could resolve the current solar metallicity problem. The first direct detection of pp solar neutrinos, John Bahcall's "gold ring of solar neutrino physics and astronomy", would allow us to test the luminosity constraint of the Sun.

LaTorre also participated in the recent "air-fill" tests on site, during which high voltage was applied to the PMTs for the first time in almost 4 years. These runs tested the new electronics and monitoring tools. The inset shows the SNO+ event display in action, and 1 of the 19 front-end electronics crates taking data.



SNO+ will turn on at the end of 2012 with a light water target, for detector calibration and a study of nucleon decay. The solar phase will start in 2013, with $0\nu\beta\beta$ running currently scheduled for early 2014.

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NSD Fragments

The American Chemical Society held a half-day symposium honoring Al Ghiorso (NSD, 1915-2010) at their 244th National Meeting, in San Diego, CA, on March 25th. NSDs **Darleane Hoffman** gave two talks, on "Early Life of Albert Ghiorso: Preparation for future role as innovator and alchemist" and "Elemental Challenge: Approval of Ghiorso's proposal of the name 'seaborgium' for element 106."



Former NSD director **Lee Schroeder** received the "2012 Alumni Lifetime Achievement Award in the Sciences from Drexel University, his alma mater. Schroeder was honored for his contributions to the fields of nuclear and particle physics, and for his efforts to found the new research area of relativistic nuclear collisions. He is shown here (right) with 2012 Nobel Prizewinner Brian Schmidt, who was also honored.



Newsletter Notes

Please send any comments, including story suggestions to **Spencer Klein** at srklein@lbl.gov.

Previous issues of the newsletter are available at:
<https://commons.lbl.gov/display/nsd/NSD+Newsletter>